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Q.TOOL

UK PATENT PENDING

A new approach to carbon tool manufacture

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Background: Standard tooling systems

- The manufacture of carbon mould tooling is well established, typically:

Carbon tooling	200 gsm Twill 2x2 surface plies 645gsm twill 2 x 2 bulk plies

- Traditional 1:8:1 tooling systems offer: Twill 2 x 2 surface ply provides a drapeable material to mould over complex shapes; good surface finish when properly debulked. Bulk plies are used to build thickness; traditionally these are twill weave - selected for drapeability and to mitigate the risk of laying the fabric the wrong side down.
- Demand in the market for 1:4:1/1:5:1 carbon tooling: the advantages of reducing time required in carbon tool manufacture.

The well-known, industry standard tooling layup has been around since the 1980s, and whilst there have been attempts to produce a system by which tools could be made more quickly, these have had limited success particularly with the reliability of achieving a very good surface finish. Q.tool is a new approach to carbon tool manufacture, providing a brand new technology to the market.

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Issues with 1:5:1

1:5:1 has not infiltrated the market as expected. With its time saving advantages, we looked to understand the issues:

- Twill 2 x 2 is the most commonly used fabric to make composite tools, has each weft fibre tow passing over 2 warp fibre tows and then under 2, across the width of the fabric. Each subsequent weft fibre is offset creating a pattern that gives a diagonal appearance.
- The slope of the fibres create areas of enclosed free space; volume within the fabric not filled with fibre. These areas, when filled with matrix, are the areas where air in the prepreg will migrate.
- Heavier fabrics made from carbon tow with higher linear density will have more crimp and consequently more enclosed free space.
- Insufficient consolidation will lead to pinholing in the surface layer and porosity throughout the thickness of the tool laminate stack.

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A new approach

Our initial aims at the beginning of development:

- Production of a carbon tool in 7 layers, 1:5:1, that for most applications will completely replace the common 1:8:1 construction.
- A new design of bulk ply that has the same mass of fibre in 5 layers as the conventional 1:8:1 construction, i.e. c.5100 gsm.
- A balanced layup, both interlayer and intralayer.
- A highly drapeable and well-impregnated bulk ply.
- Reduce the number of debulks to a maximum of 2.
- Reduce the amount of vacuum bag consumable materials – mostly plastic.
- Reduce the layup time by a minimum 33%.

Create a new, unique tooling system to manufacture composite tools in less time and with less expense.

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What we achieved

Now developed, Q.tool prepreg tooling technology provides:

- Over 50% saving in labour/time compared with established materials and methods
- Reduces required debulks to as few as 1
- Improved mould surface finish
- Reduced through-thickness porosity
- Exceptional drapeability – will easily mould complex shapes
- Reduction of plastic and other vacuum bag consumables
- Increase in reliability; the design of the material decreases the risk of errors in laying up
- Reduces energy required in manufacturing and considerable reduction of consumable plastic – provides improved sustainability
- **UK Patent Pending – this is a unique tooling technology**

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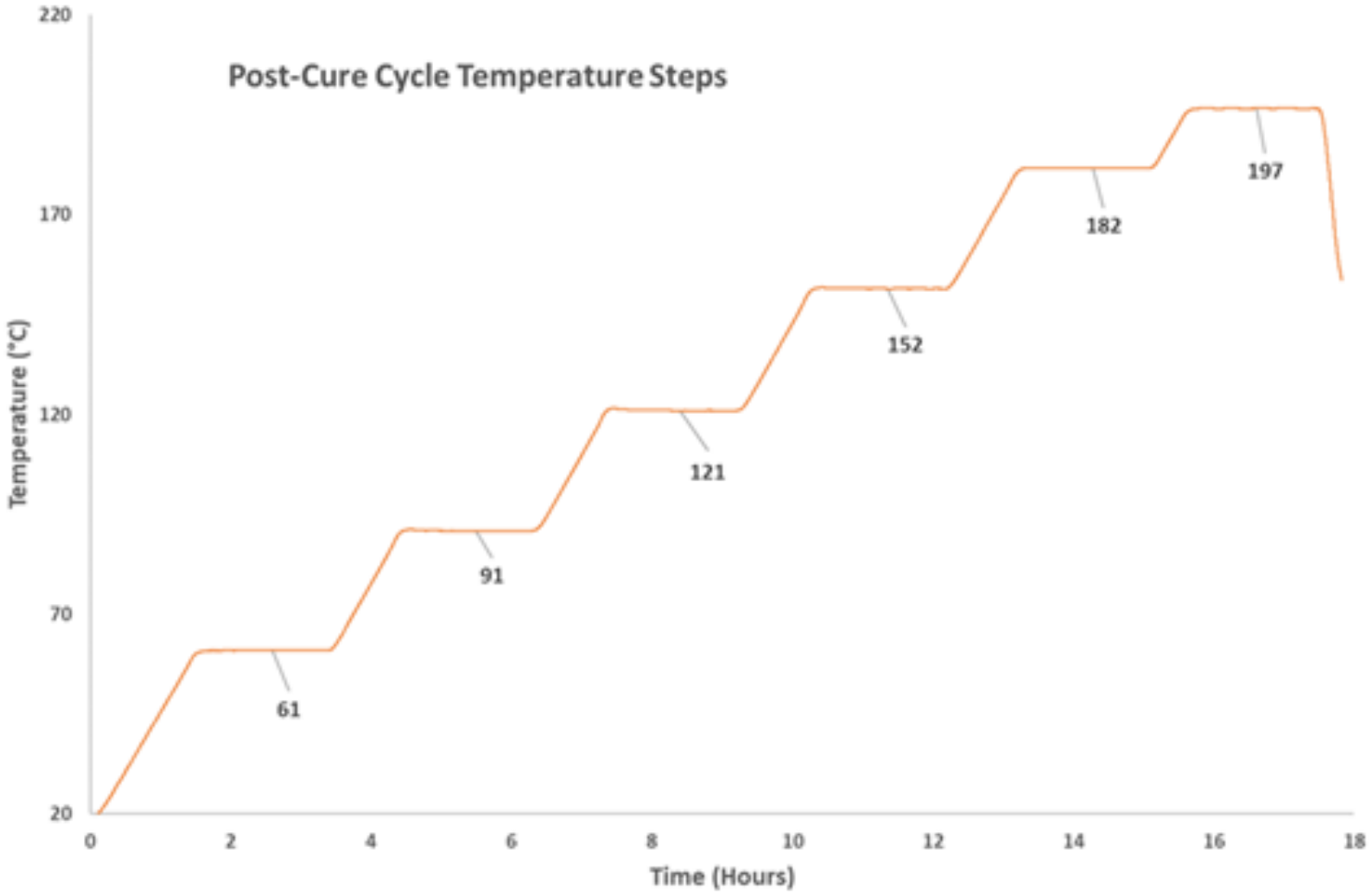
Q.tool prepreg system: RP800 Epoxy tooling prepreg



Key properties:

- Flexible cure cycles:
  - 45°C - 12h
  - 50°C - 8h
  - 70°C – 5h
- Post cure: 195°C
- Out life – 6 days at 20°C
- Tack life – 5 days at 20°C
- Excellent and durable tool surface finish, even after repeat mouldings

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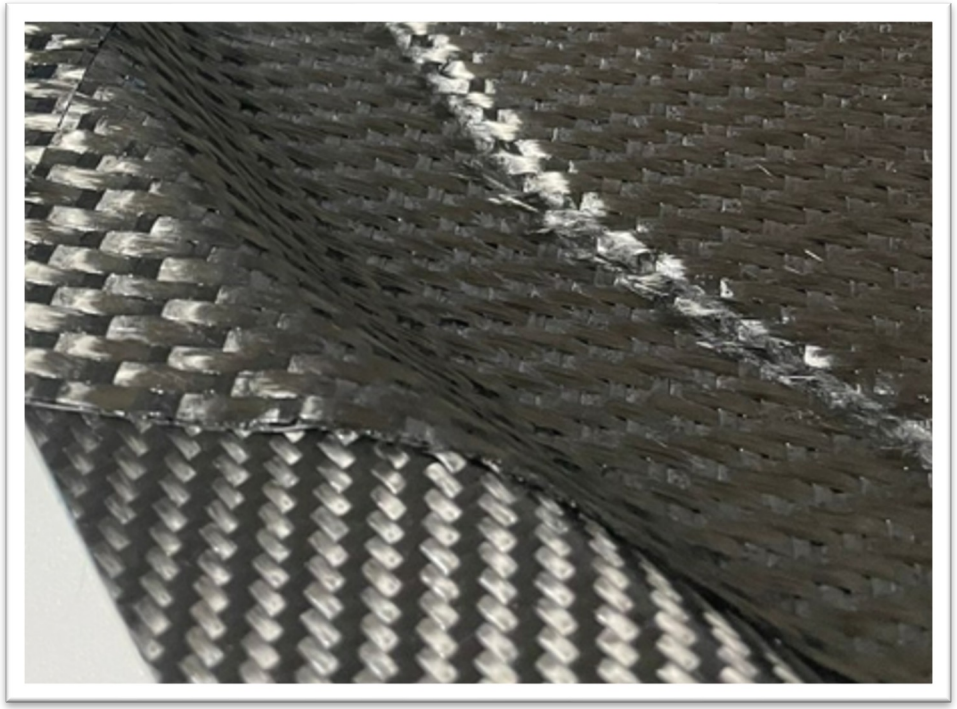
Case Study

Piran Advanced Composites:

- Have chosen to use Q.tool with the aim of reducing manufacturing time in tooling layup.
- Being trialled on two separate projects: large structure minimal contours and high volume, compact tools with more complex geometries.
- On both projects, there is a significant time saving due to the material being supplied in squares – kit cutting operation has been eliminated and stock control activities reduced.
- Good drapability of surface and bulk ply, so no limitations from the bulk ply being thicker vs. not being able to manufacture complex geometries.

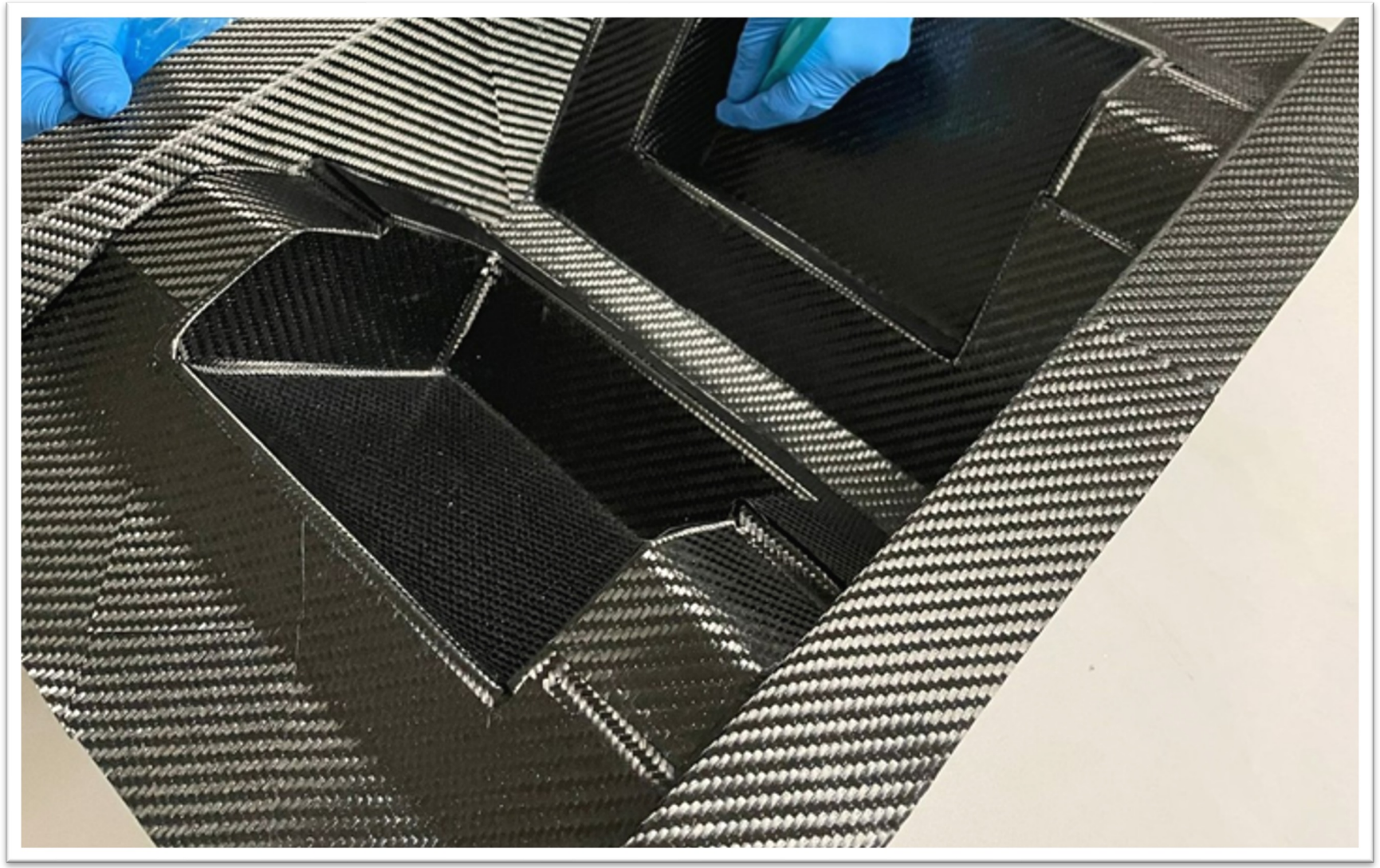
Benefit of using Q.tool on large structure, minimal contour tools:

- Majority of tiles can be laminated whole, reducing layup time, number of cuts and number of blades.
- As minimal contours exist, bulk ply drapability was not crucial and no issues from ply thickness were encountered.



Benefit of using Q-tool on high volume, compact tools with more complex geometries:

- Less debulks required = considerable time saving
- Laminating time increased per bulk ply due to the added thickness and difficulty cutting, but when balanced against the reduction in ply, the overall laminating time is lower.



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- Total saving of time/labour over 50%
- Reduced number of debulks, to as few as one
- Considerable financial savings on consumables
- Improved tool quality and exceptional surface finish, from our highly drapable prepreg technology
- Available from stock, cut into tile kits ready to use and we can also deliver boxless – in our new cradle – removing some of the unnecessary packaging that will go to waste.
- Our new Fast to freeze process – we have developed a process to manufacture, cut and freeze our prepreg in less than 6 hours, significantly preserving the material's out life in our tile kits.
- A more sustainable tooling system, providing significant energy savings and reduced use of consumable plastic.

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Doing things differently

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